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The Distribution and Relative Abundance of Arctic Grayling (Thymallus Arcticus) in the Parsnip, Anzac and Table Rivers

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Abstract

Arctic grayling (*Thymallus arcticus*) stocks in the Williston Reservoir Watershed severely declined during the 1980's. Studies have been underway on the Parsnip River and its tributaries since 1995 to gather information that can be used to prevent further population declines and formulate recovery plans.

In 2000, beach seines and underwater counts were used to monitor juvenile and adult Arctic grayling numbers at selected sites within the Parsnip watershed. Ninety beach seine sites (one bank, 8250 lineal metres of river) were sampled in a 50 kilometre section of the Parsnip River. A average of 46 young of the year and 29 , one year old Arctic grayling were captured per kilometre seined. These numbers were comparable to the 48 young of the year and 26 one year old grayling captured from the same area in 1998. The distribution of both age classes appeared to be random along the river and there was no evident relationship between the number of fish captured at a specific site between years. Also sites with highest fish numbers were often adjacent to sites with similar habitat but with few fish. In 2000 the one year old grayling were significantly smaller ($P<.05$) than in 1998, but fry sizes were not significantly different ($P<.05$).

Beach seining appeared to be a reliable method to monitor juvenile grayling numbers. Adult numbers were monitored using multiple underwater counts in the Table and Anzac rivers, two clear water tributaries of the Parsnip River. Heavy rains reduced underwater visibility (siltation) and prevented the completion of the adult underwater counts in the Anzac River. But in the Table River, the highest numbers of adults were counted in the uppermost accessible reach, a pattern similar to previous surveys. The average count of adult (> 20 cm fl) grayling in the upper reach of the Table River in 2000 was 31/km (24 ha^{-1}), which was comparable to 34 and 32/km in 1998 and 1995. The count from the upper reach of the Anzac River was down to 34/km from 82/km in 1998. This change was probably due to a change in distribution rather than a drop in numbers. Underwater counts were used to compare adult numbers rather than mark recapture estimates because previous studies found that up to 40 % of the Arctic grayling left the four kilometre long index sections after they were captured and marked with spaghetti (floy) tags. Underwater adult counts, and beach seining for juveniles and fry appears to be a reliable and cost effective method to monitor these populations.

INTRODUCTION

Arctic grayling populations in the upper Peace River drainage have declined severely since the mid-1980's (Northcote 1993, Blackman et al 1990). This area drains into Williston Reservoir, the largest body (1,736 km^2) of freshwater in British Columbia. This storage reservoir was formed by the construction of the W.A.C. Bennett Dam in 1968 and has a drainage area of 70,000 km^2, an area the size of the province of New Brunswick. Very little information is available about fish distribution prior to the creation of Williston Reservoir. Arctic grayling were the most numerous sport fish species found in the majority of rivers tributary to the reservoir in 1974 (Bruce and Starr 1985) and this species was also abundant in the reservoir (Barrett and Halsey 1985). Arctic grayling numbers remained high until the early 1980's when numbers appear to have crashed. By 1988, this species had almost completely disappeared from the reservoir (Blackman 1992[a]) and from most moderate to small streams (Blackman 1992[b]).

Arctic grayling populations inhabit the larger rivers (drainage area > 2000 km^2) entering Williston Reservoir, but rapid resource development and improved angler access, threatens these stocks. In response to the decline of Arctic grayling stocks within the watershed, the B.C. Conservation Data Centre has designated the species as "red listed" (QS1) or critically imperilled and catch and release regulations have been imposed in this watershed. The Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) has been conducting projects in this watershed since 1988 with the objective of compensating for impacts caused by the formation of the reservoir and the flooding of the large riverine habitats.

Arctic grayling are a priority species for the PWFWC P. To date, projects have documented the decline and present distribution of Williston Watershed Arctic grayling stocks (Blackman 1992[A], Blackman and Newsholme 1993, Langston and Blackman 1993). The B.C. Conservation Data Centre "red listed" designation for Arctic grayling was based on data provided by the Program. A review of management and enhancement options in the watershed has been conducted (Northcote 1993). A long term project (1992-2002) to determine the effects of stream fertilization on Arctic grayling populations is underway (Larkin et al. 1999). In 1994, a number of studies,(Zemlak and Langston 1998, Langston 1998, Mathias et al 1998, Blackman and Hunter 2001, Blackman 2001[A]) co-funded by Forest Renewal B.C., were initiated to document distribution, relative abundance, habitat utilisation, and migratory patterns of Arctic grayling in the Table and Anzac River watersheds. Work was initiated in 1996 to evaluate the genetic structure and degree of similarity of Arctic grayling populations within the Williston Reservoir watershed. The overall goal of these Arctic grayling projects is the preservation and restoration of Arctic grayling stocks and habitats within the Williston Reservoir Watershed. In order to accomplish this goal a management plan has been developed (Blackman 2001[b]). The plan identifies methods to determine limiting factors, critical habitats, cost effective techniques to monitor changes in populations and suggests how populations can be re-established in historic habitats.

The objectives of the 2000 field program on the Table and Anzac Rivers were:

1. gather information on the distribution and relative abundance of Arctic grayling young of the year and juveniles in a 50 km section of the Parsnip River, and compare this with data collected in 1998.
2. determine if beach seining would be suitable to monitor changes in Arctic grayling recruitment in this area.

3. establish potential index sites to monitor changes in Arctic grayling recruitment over time.
4. conduct underwater counts at index sites in the Table and Anzac rivers to monitor long term changes in adult populations.

Study Area

Life history and habitat utilisation studies on Arctic grayling have been conducted, since 1994, on the Table and Anzac rivers, which are located 100 km north of Prince George, B.C. These two rivers flow west, out of the Misinchinka Ranges of the Rocky Mountains, into the Parsnip River 75 km upstream from Williston Reservoir. The Parsnip River and its tributaries are the southern most extent of Arctic grayling in B.C. The physical characteristics of the Table and Anzac rivers are very similar but the Anzac was in a relatively pristine state at the start of the studies in 1995, and the Table River has been seriously impacted by resource development. A detailed description of these rivers is given in Blackman and Hunter (2001).

A section of the Parsnip River from the confluence of the Table River at km 91 downstream to km 39 was included as part of the study area in 2000 (Fig 1). The Parsnip River flows in a northerly direction for 175 km to Williston Reservoir and has a drainage area of 4,669 km^2 (Bruce and Starr 1985). The mean daily flow rate from 1985 to 1995 was 142 m^3sec^{-1}. During this period, the average maximum daily flow rate was 824 m^3sec^{-1} and the minimum 23 m^3sec^{-1}. The lowest flows occur between September and March, with freeze-up occurring in November (Water Survey of Canada records). This river is low gradient (0.3%) and is unconfined. Much of the soil adjacent the river is composed of fluvial silts and as a result bank stability can be poor and water clarity is low (Bruce and Starr 1985).

The section of the Parsnip River where the surveys occurred (km 39-91) has three reaches (White 1998). The upper boundaries of reaches were at km 55 (R#3), km 75 (R#4) and at km 90 (R#5). All three reaches had wetted widths of 60 to 70 metres. Channel widths were 60-70, 80 and 60 m respectively. The dominant substrate was gravel but cobble was the subdominant substrate in reaches 3 and 4. Fines were the subdominant substrate in Reach 5. Spawning potential was rated as moderate to good in reaches 3 and 4 but poor in Reach 5. Reaches 3 and 4 had extensive gravel bars, and side channels and roughly 35% of the habitat was riffle. Reach 4 has ox bows and was bordered by several large wetland areas. White(1998) suggests that up to 40% of the area (reach 3-5) was riffle habitat, but personal observations were that there was almost no riffle habitat in Reach 5 and that there are very few gravel bars. The reach was dominated by long slow glides. Bank materials were primarily glacial, which has resulted in poor bank stability and a high fines content in many areas.

Fish species identified in the Table, Anzac, and Parsnip rivers include: Arctic grayling, bull trout *(Salvelinus confluentus)*, rainbow trout *(Oncorhynchus mykiss)*, mountain whitefish *(Prosopium williamsoni)*, lake whitefish *(Coregonus clupeaformis)*, burbot *(Lota lota)*, northern squawfish (now northern pikeminnow) *(Ptychochelus oregnensis)*, largescale suckers *(Catostomus macrocheilus)*, longnose suckers *(Catostomus catostomus)*, white suckers *(Catostomus commersoni)*, slimy sculpins *(Cottus cognatus)*, prickly sculpins *(Cottus asper)*, and longnose dace *(Rhinichthys cataractae)* (Anonymous 1978). Redside shiner *(Richardsonius balteatus)*, peamouth *(Mylocheilus caurinus)* brassy minnow *(Hybognathus hankinsoni)* and kokanee *(Oncorhynchus nerka)* may also be found in this drainage (McPhail and Carveth 1993).

METHODS

Parsnip River Juvenile Distribution

Sampling was carried out on the Parsnip River between July 18 and August 9, 2000. Approximately 90 beach seine sets were conducted at 49 sites between the Table River confluence at kilometre 91 and kilometre 39 (Fig 1). Sites were chosen at locations where beach seines would be reasonably efficient. Areas with woody debris and undercut banks or steep banks were avoided. Nearly all suitable sites upstream from km 55 were sampled but not all the sites from km 39 to 55 were sampled because of time constraints. In Reach 5 some very marginal areas (steep banks, woody debris, mud or silt substrate.) were sampled because of the limited amount of suitable seine sites.

A 30x4 m beach seine with 9 mm mesh was used to capture fish. One end of the net was held on shore while the net was laid out from a jet boat. The net was set perpendicular to the shore for 15-20 m, and then the remaining net was set in a downstream direction. Once the net was fully stretched out, tension was kept on the mid channel end using the jet boat and both ends were allowed to drift down the river at the same speed as the current. The length (m) of each set was measured with a laser rangefinder (to the nearest 5 metres) and set lengths were adjusted so that all suitable locations could be sampled. The length (m) of the sets were also adjusted so that the net was not beached in areas with large boulders, high velocities and very steep or shallow shorelines if possible.

All Arctic grayling, rainbow trout, and bull trout fork were measured and weighed. Arctic grayling were recorded as young of the year (YoY) (fl≤77mm), 1+ (fl>78 and <153) and 2+(>154 mm fl) based on analysis of their scale development. Mountain whitefish counts were divided between young of the year (<80mm) and older fish. Scale samples were collected from the Arctic grayling and rainbow trout. Passive integrated transponder (PIT) tags were applied to all Arctic grayling weighing over 6.5 g using the methods outlined by Prentice *et. al.* (1990 and 1990a). The PIT tagged Arctic grayling were adipose clipped and released back into the site. If an adjacent site was to be sampled, the fish were not released until the second site had been seined. The numbers of other fish species captured in the beach seine were also recorded. No differentiation was made between largescale and white suckers because they hybridise in this area and it was necessary to remove them from the nets as quickly as possible to reduce fry mortalities. UTM co-ordinates were recorded for each sample location.

On August 10th and 11th, velocity and depth measurements were recorded at all of the seine sites. Water velocity was determined using a floating orange over a 20 m section in the middle of each site. Depth measurements were taken 10 m from the shore at each end of the 20 m section and these two measurements were averaged to give a depth for the site. Substrate was evaluated visually and recorded as percentages of fines, gravels, and cobble.

Adult Abundance Estimates

Adult abundance estimates for Arctic grayling, rainbow trout, bull trout, and mountain whitefish were conducted on the Table and Anzac rivers from August 15th to 18th, 2000. Three sites, one per accessible reach on the Table River (km 35-31, km 22-18, km 9-5) and one site on the Anzac River (km 47-45) was surveyed. Five sites were planned for the Anzac River, but poor underwater visibility prevented completion of the work. Wetted width and underwater visibility was recorded at the start of each swim. Adult abundance was estimated using multiple counts conducted by five swimmers. In the upper (narrower) portions of the rivers, the counts

were conducted by two crews of two, twice (a total of four counts). In wider sections, one crew of three swimmers and one crew of two swimmers did two counts each. Crews were taken to the sites by a helicopter, which would wait at one kilometre intervals along the river where the pilot would record the fish counts for that kilometre of river for both crews. The second crew (two person) would start the counts approximately 10 minutes after the first crew. Each swimmer was assigned a lane, and recorded the number, species, and the size range (10 cm increments) of all fish seen in that lane. On the second count the swimmers would change lanes and crew members were changed at each new site. Only fish greater than 20 cm were included in the abundance estimates so that the data would be comparable with previous surveys. Swimmers changed lanes on the second swim and crew members rotated to a different position at each different site. This resulted in two counts for each site by a two person crew and two counts from a two or three person crew. There was no obvious bias towards three swimmers counting more fish than two so the counts were treated the same.

Abundance estimates were made by averaging the four counts for each section. Mark recapture estimates were not used because previous surveys (Blackman and Hunter 2001) showed that up to 40% of the marked (floy tagged) grayling moved out of the area after being tagged. Expanded counts were also not used because this method had also been found to give erroneous results.

RESULTS

Parsnip River Juvenile Distribution

Ninety beach seine sets were conducted at 49 sites between the confluence of the Table River at kilometre 91 and kilometre 39 of the Parsnip River from July 18th to August 9th, 2000. A total of 8,255 lineal metres (one bank only) of stream or approximately 12.4 ha were netted. The number of Arctic grayling captured was 376 young of the year (45.5/km), 237 one-year-old (28.7/km), and 52 (6.3/km) grayling older than 1 +(Table 1). PIT tags were applied to 212 of the 1 + and older grayling. In addition, 3,396 young of the year, and 828 older mountain whitefish, 35 lake whitefish, 37 rainbow trout, 29 bull trout, 8 kokanee, 112 longnose suckers and 207 white / largescale suckers were captured. No young of the year bull trout and only one young of the year rainbow trout were captured. The kokanee that were captured all appeared to be young of the year (55-72 mm fl). The average fork length of the young of the year grayling was 48.7 mm (±1.4) and one year old grayling had an average fork length of 100 mm (±2.0).

Adult Abundance Estimates

The underwater counts were terminated on August 18th because of unfavourable weather conditions. Underwater visibility had deteriorated from 7 metres on the first day (upper Table River) to less than 3 metres on the last day (upper Anzac River). Water conditions remained poor for the next two weeks, preventing completion of the surveys.

Underwater counts for Arctic grayling were highest in the upper Anzac with 34 grayling per kilometre and the upper Table with 27 per kilometre, but the counts were down to under 3 per kilometre in the lower Table River (Table 2). Arctic grayling were more numerous than either bull trout or rainbow trout at all sites except the lower Table River where rainbow trout counts were 30 per kilometre. Bull trout counts ranged from a high of 30 per kilometre in the

upper Table to less that six in the middle reach of the Table. Mountain whitefish were the most numerous species with counts from 30 to 600 per kilometre.

DISCUSSION

Parsnip River Juvenile Distribution

Sites with higher numbers of fish were frequently adjacent to sites with similar habitat but low numbers of fish. Nor does there appear to be any strong relationship between the number of grayling captured at a given site in this study to the number of grayling captured at the same site in 1998 (Fig 4 & 5). In 1998, there appeared to be higher numbers of grayling fry and juveniles just downstream from the confluence of the Anzac River. But in 2000 there was no strong indication of increased numbers down stream from the mouth of the Anzac River at km 64, nor from the Table River at km 90, or Reynolds Creek at km 44 (Figs 2 & 3). The average number of grayling captured per kilometre of river was 46 YOY and 29 one-year-old grayling. This is very similar to 48 YOY and 26 one-year-old-juveniles captured per kilometre in 1998. These numbers are indexes of abundance and were obtained by sampling habitats which were identified as suitable as a result of work conducted in 1998 (Blackman and Hunter 2001).

The beach seine did not appear to be particularly efficient at capturing YOY, particularly in areas with cobble or boulder substrates. An electrofisher would provide more consistent results, since over 90 % of the fry in these systems live within three metres of shore and in less than 30 cm of water (Blackman in prep).

The beach seine does appear to be effective for collecting 1+ and older grayling. This age class was most frequently found in large, slow moving glides, 40-100 cm in depth over a gravel or cobble substrate (Blackman and Hunter 2001). This type of habitat would be impossible to sample effectively with a backpack electroshocker. Juveniles and adults could also be effectively sampled using a boat electroshocker, although some of the more shallow habitats could be problematic.

A comparison of the length frequency distribution of the grayling captured during July in 1998 and 2000 shows some interesting patterns (Fig 6). The mean fork lengths of the YOY fry were virtually identical at 48.7mm in 2000 and 49.7mm in 1998, but the variation in the 2000 population was much greater. The one year old fish were significantly ($P<0.05$) smaller in 2000 (mean fork length of 100 mm fl vs 114 mm) but had the same condition factor (0.95). The differences in growth rates is probably attributable to the timing of spawning and stream temperature conditions.

Adult Abundance Estimates

The average number of Arctic grayling counted (123) from the upper Table River index site was similar to the counts from 1998 (136) and 1995 (127) (Table 3). The average counts made from the other sites on the Table River, although more variable, were also similar to the previous counts. This simple counting technique appears to provide a cost effective index method to monitor adult Arctic grayling populations. Under ideal conditions, the counts should provide an estimate that is very close to the actual population. The success of this method depends on underwater visibility (>3m), the experience and consistency of the swimmers, and having a sufficient number of swimmers to cover most of the width of the river. Previous studies conducted on these systems (Blackman and Hunter 2001) using mark recapture methodology

counted over 90% of the marked (spaghetti tags) grayling from areas where the marked fish did not move after being tagged. However, simple counts may not be as effective with species such as rainbow trout and bull trout, which tend to be more elusive than grayling. The previous works also found the distribution of adult Arctic grayling differed from year to year and is probably affected by stream water levels and temperatures. Adult grayling tend to become more concentrated in the upper reaches as water levels drop in late summer, but if water levels do not drop, more adults tend to remain in the lower and middle reaches. This may account for the dramatic change in the count from the upper Anzac River, which was less than half the count obtained in 1998. This potential yearly variation in distribution makes it advisable to survey all the reaches of a system in order to monitor population trends. Monitoring adult population trends by underwater counts may be a relatively insensitive method to evaluate the effects of specific enhancements, habitat degradations or management decisions on a population. For example, the Table and Anzac rivers provide summer feeding habitat, and are populated by adult grayling, which may have reared in other systems (Blackman 2001 [a,b]). This tendency for adults from several different sources to summer together is not unusual for grayling (Armstrong 1986) but it does make evaluating impacts on populations somewhat more difficult.

ACKNOWLEDGEMENTS

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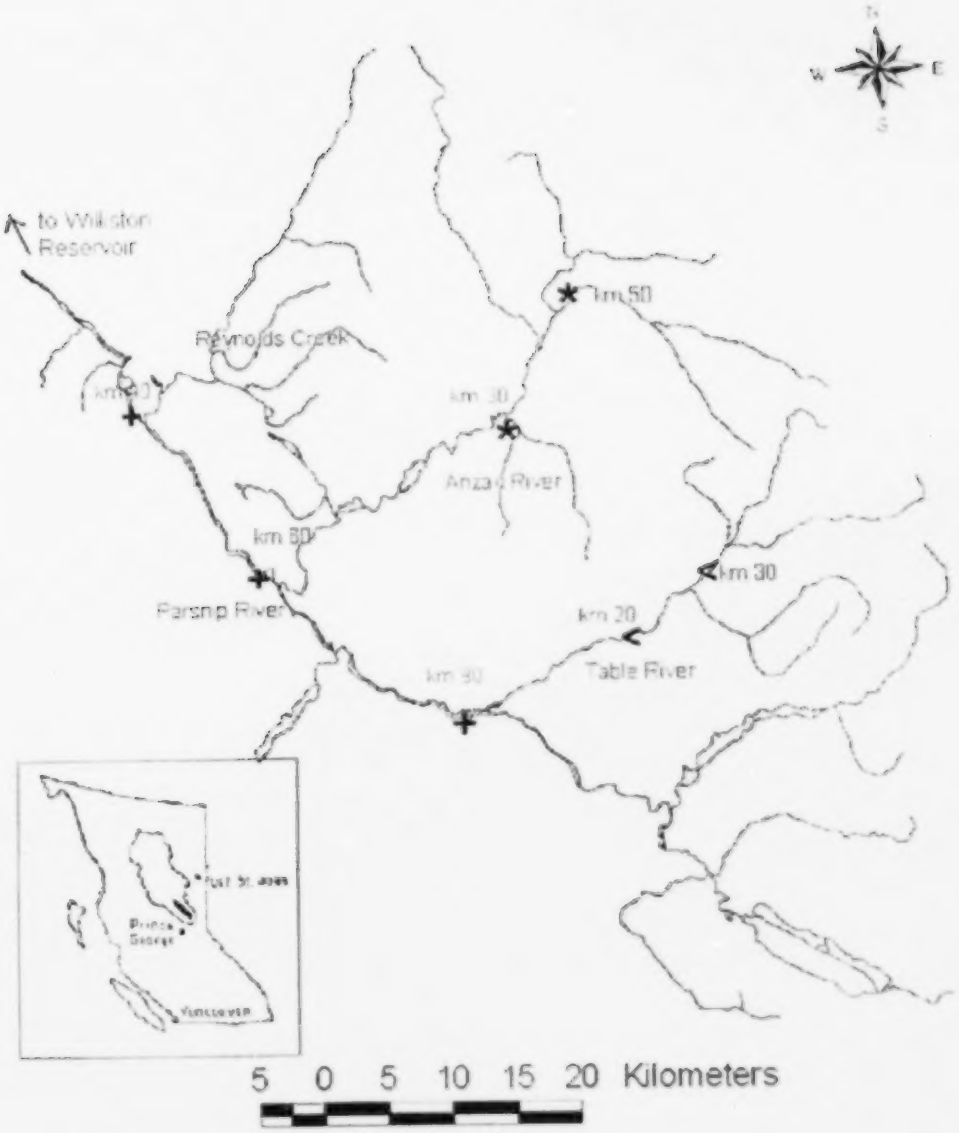

Figure 1. Location of the Table, Anzac and Parsnip rivers.

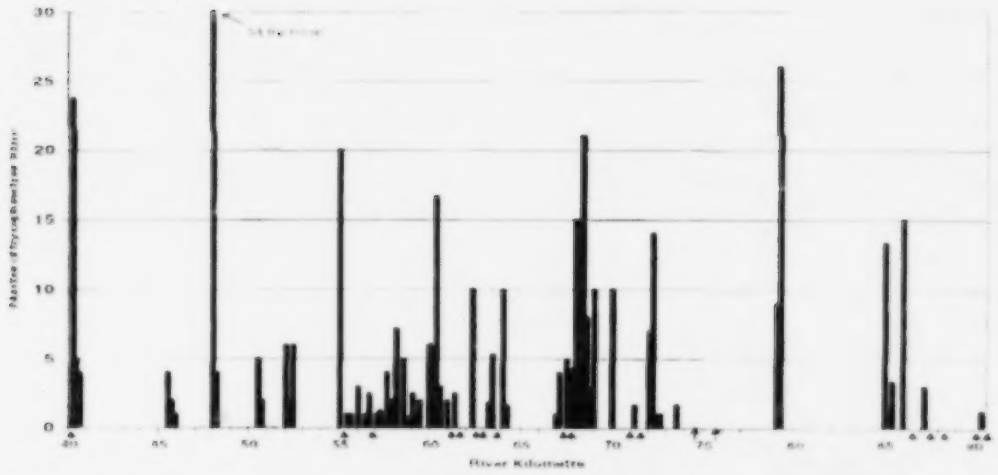

Figure 2. Young of the year grayling catch distribution from beach seine locations on the Parsnip River in 2000. Locations where no grayling fry were captured are shown as triangles.

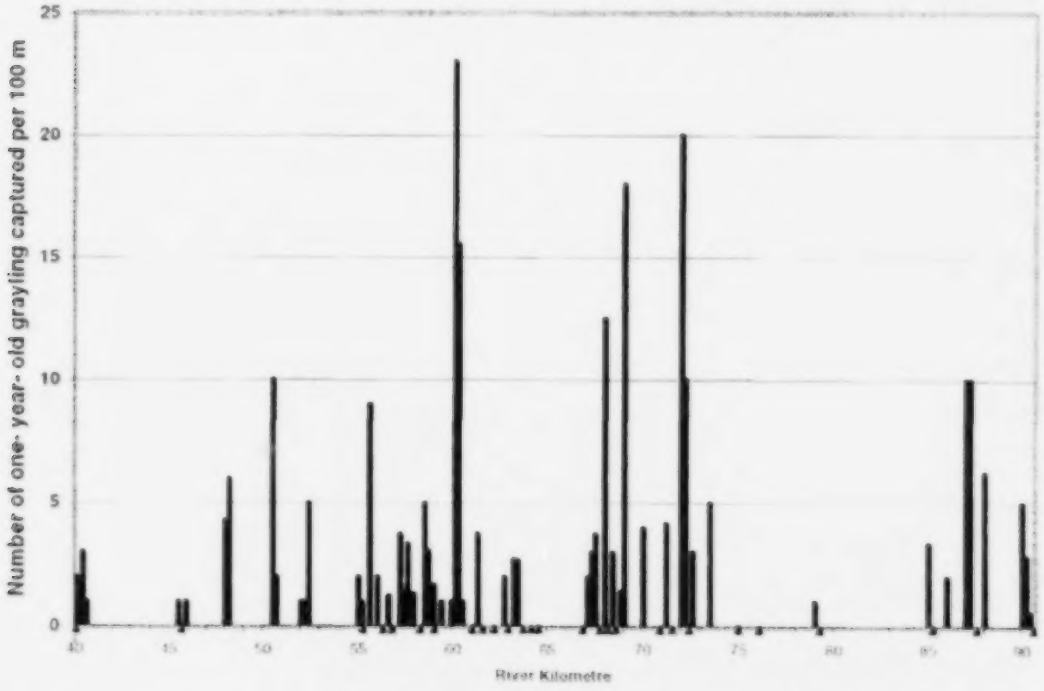

Figure 3. One year old grayling catch distribution from beach seine locations on the Parsnip River in 2000. (Locations where no one-year-old grayling were captured are shown as triangles).

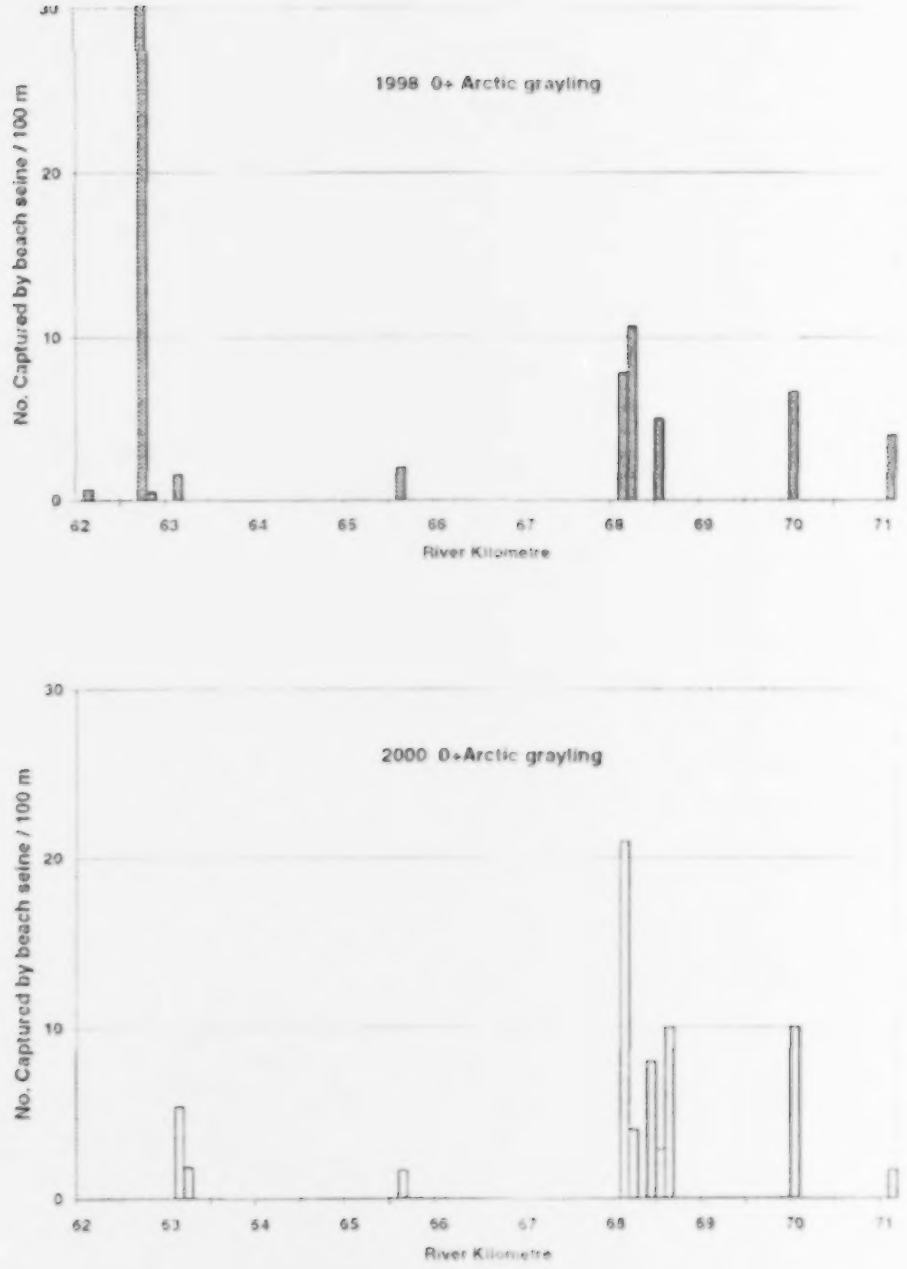

Figure 4. Comparison of Young of the Year Arctic Grayling catch data from sites sampled in 1998 and 2000, corrected to number per 100 m.

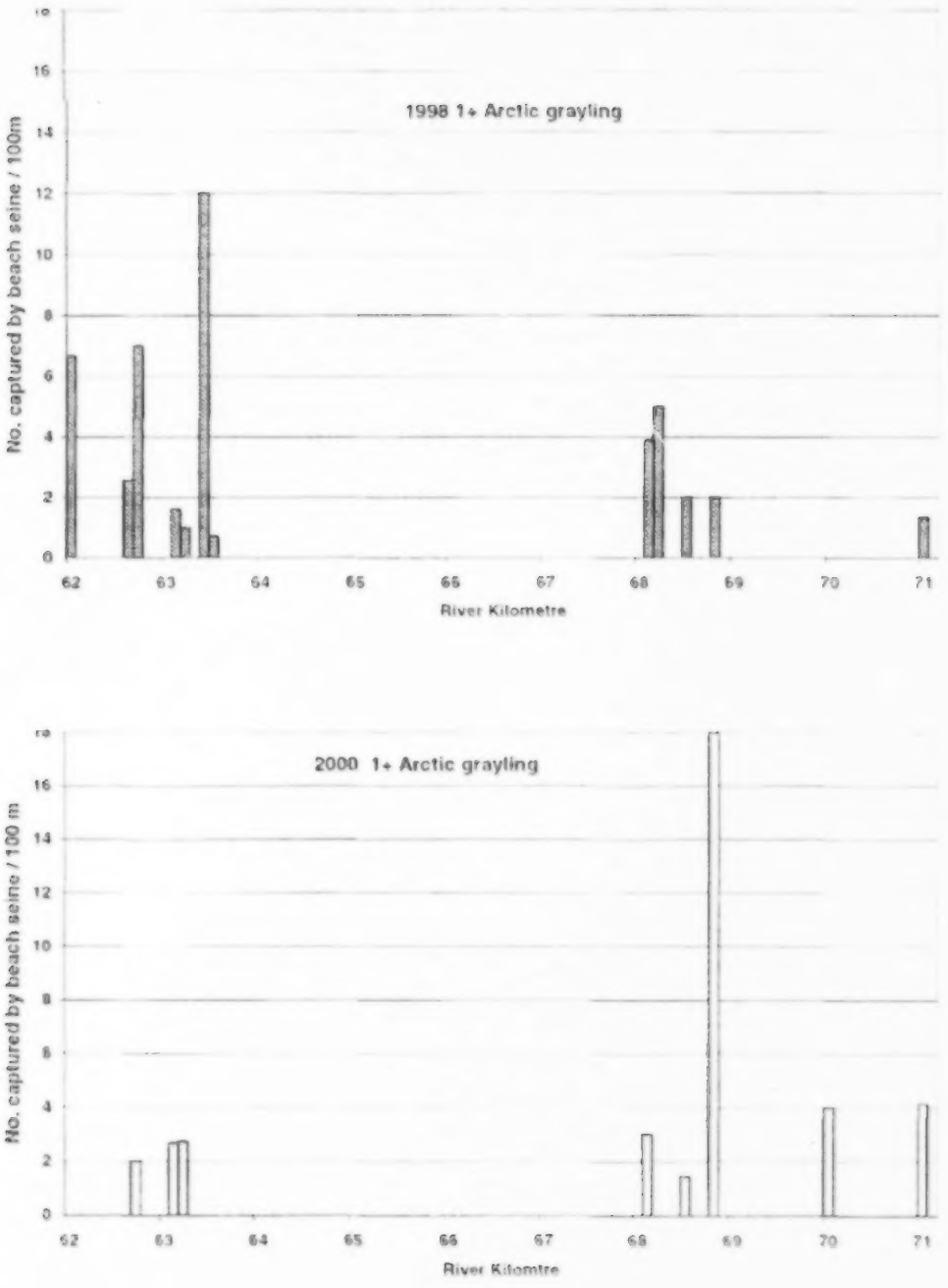

Figure 5. Comparison of one year old grayling catch data from sites sampled in 1998 and 2000, corrected to the number captured per 100 m.

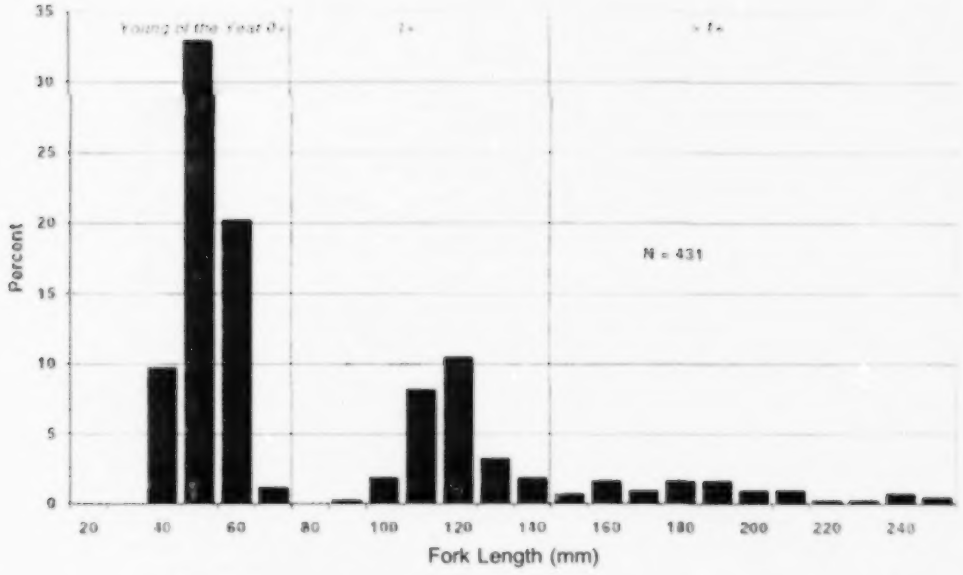

Figure 6. Length frequency distribution of Arctic grayling captured by beach seine from the Parsnip River during July in 1998.

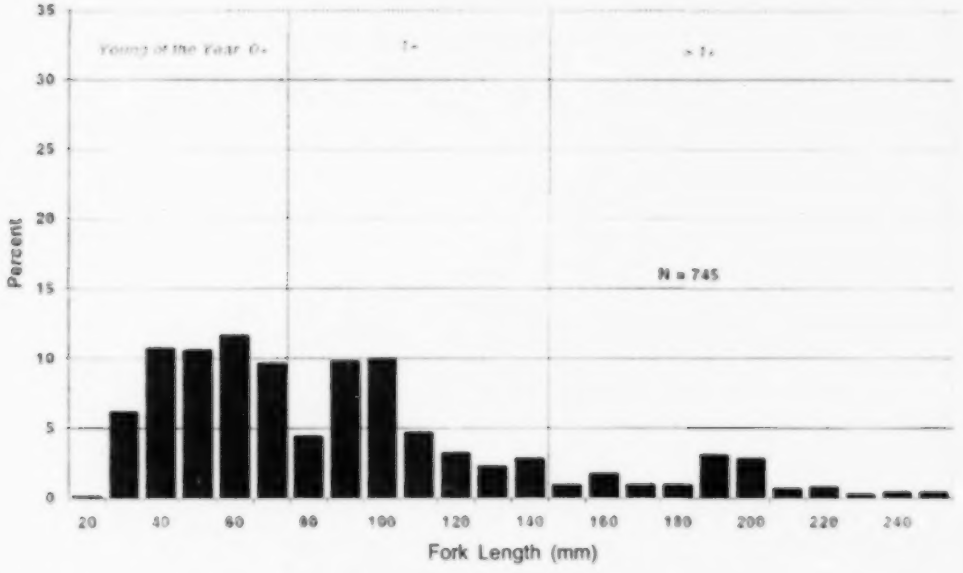

Figure 7. Length frequency distribution of Arctic grayling captured by beach seine from the Parsnip River during July, 2000.

Table 1 Distribution of fish captured by beach seine from the Parsnip River, July 2000.

River	No.	No.	Length	Number															
	of	of	Sampled	GR	GR	GR	MWF	MWF					WSS						
km	Sites	Sets	(m)	0-77	78-153	>154	0-80	>80	LWF	RR	RT	LNS	LSS	LND	RRE	NP	CC	PMC	KO
39	1	1	120	1	0	0	13	4	2	0	1	0	1	0	0	0	0	4	0
40-44	1	4	430	28	7	0	309	4	0	0	0	0	0	4	0	0	4	0	0
45-49	2	5	470	49	11	1	52	28	0	0	3	3	24	1	0	0	1	0	0
50-54	4	5	500	21	19	3	166	40	0	3	3	17	18	2	0	0	3	1	0
55-59	11	19	2040	57	40	11	548	148	14	12	9	22	44	6	62	13	5	22	0
60-64	7	16	1445	50	49	11	274	115	5	4	2	5	20	3	2	1	9	2	1
65-69	7	15	1165	69	31	6	308	165	0	6	1	34	6	3	7	3	0	11	7
70-74	5	9	755	35	45	3	380	159	11	9	9	6	87	0	0	20	2	5	0
75-79	3	4	300	35	1	1	484	11	1	0	0	1	0	0	0	0	6	0	0
80-84	0	0																	
85-89	5	8	650	29	29	2	763	67	0	1	0	5	0	0	0	1	6	1	0
90-91	3	4	380	2	5	14	99	87	2	?	1	19	7	0	0	2	1	0	0
Total	49	90	8255	376	237	52	3396	828	35	37	29	112	207	19	71	40	37	46	8

River km - distance in km from mouth, Length Sampled - length of shoreline, GR Arctic grayling (fl sizes given in mm), MWF mountain whitefish(fl sizes given in mm), LWF lake whitefish, RB Rainbow trout, BT bull trout, LNS longnose sucker, WSS white sucker, LSS largescale sucker, LND longnose dace, RRE redside shiner, NP northern pike minnow, PMC peamouth chub, KO kokanee.

Table 2. Underwater Fish Counts in the Table and Anzac Rivers, August 2000.

	Table R	km 35-31	Table R	km 22-18	Table R	km 9-5	Anzac R	km 47-45
Swim Length	4600 m		4000 m		4000 m		2000 m	
Fish Counted	Mean No.	95% CI	Mean No.	95% CI	Mean No.	95% CI	Mean No.	95% CI
Species								
Arctic grayling	123	±20	37	±4	11	±1	68	±2
Bull trout	30	±10	6	±2	9	±2	16	±4
Rainbow trout	9	±5	24	±14	30	±11	8	±8
Mountain whitefish	636	±298	82	±51	28	±9	217	±78

Table 3. Comparison of Underwater Fish Counts on the Table and Anzac Rivers.

Table River km 35-31					2000					1998				1995				(km 35.5-32)	
					Mean	Std	95%CI			Mean	Std	95%CI				Mean	Std	95%CI	# adjusted for length ***
# Swimmers	2	2	2	2				2	2					2	2				
MW	427	772	346	998	635.8	304.0	298.0	99	111	105.0	8.5	11.8							
AG	101	111	136	145	123.3	20.7	20.2	137	135	136.0	1.4	2.0		107	115	111	5.7	7.8	126.9
BT	45	29	21	24	29.8	10.7	10.5	133	111	122.0	15.6	21.6		21	18	19.5	2.1	2.9	22.3
RB	12	15	6	4	9.3	5.1	5.0	103	60	81.5	30.4	42.1		8	15	11.5	4.9	6.9	13.1
Table River km 22-18																			
# Swimmers	3	2	3	2				3	3										
MW	100	14	139	74	81.8	52.5	51.4	895	892	893.5	2.1	2.9							
AG	39	30	40	38	36.8	4.6	4.5	79	54	66.5	17.7	24.5							
BT	7	5	8	3	5.8	2.2	2.2	21	16	18.5	3.5	4.9							
RB	37	9	35	14	23.8	14.3	14.0	84	54	69.0	21.2	29.4							
Table River km 9-5																			
# Swimmers	3	2	3	2				3	3					2	2				
MW	15	35	30	31	27.8	8.8	8.6	7	7	7.0	0.0								
AG	9	12	12	12	11.3	1.5	1.5	3	2	2.5	0.7	1.0		19	33	26	9.9	13.7	21.7
BT	9	10	11	7	9.3	1.7	1.7	16	5	10.5	7.8	10.8		13	13	13	0.0		10.8
RB	16	34	27	43	30.0	11.4	11.2	51	51	51.0	0.0			56	75	65.5	13.4	18.6	54.6
Anazc River km 47-45																			
# Swimmers	2	2						2	2										
MW	177	257			217.0	56.6	78.4	180	188	184.0	5.7	7.8							
AG	69	67			68.0	1.4	2.0	171	157	164.0	9.9	13.7							
BT	14	18			16.0	2.8	3.9	25	20	22.5	3.5	4.9							
RB	4	12			8.0	5.7	7.8	3	6	4.5	2.1	2.9							

***the count on the upper portion of the Table River in 1995 was from km 35.5 to km 32 (3.5 km) rather than 35-31 (4.0 km). The numbers given are an extrapolation for comparative purposes